Title: Towards close-loop tES: Workload monitoring during tACS stimulation

Authors: Siddharth Kohli *[1], Alexander J. Casson[1]

1. School of Electrical and Electronic Engineering, University of Manchester, Manchester, UK

Abstract:

EEG is commonly used to assess working memory load which can have key implications when considering decision making during critical tasks and recent studies have presented the use of transcranial Alternating Current Stimulation (tACS) to enhance working memory processes. This study presents a system that monitors workload via EEG during tACS, which can be used in the future to modulate stimulation parameters based on ongoing measures of working memory performance. EEG measures electrical activity which reflects temporal changes in the electrical state of neurons and represents the current flow, which is directly modulated when applying tACS, making these techniques compliment one-another for closed-loop neuromodulation.

Subjects performed nBAck and backwards digit-recall tasks which were repeated both with and without tACS stimulation at 5Hz, 0.5mA in a frontal-parietal montage. A feature matrix of 64 features per 5 second epochs was then extracted from EEG data collected during these tasks after tACS artifact removal and was used to train a machine learning classifier. Upon testing, the classifier was able to successfully separate EEG data during the two tasks both with and without stimulation with a performance of 81.3% and 80.6% for the nBack and digit-recall task respectively.

This is the first step towards a close-loop, feedback based tACS-BCI. EEG during tACS can be monitored in real-time to provide an ongoing assessment of workload. The next step is to develop systems which can adjust stimulation parameters such as phase matching tACS with ongoing theta activity and adjusting stimulation amplitude based on workload assessment.

Acknowledgements:

The authors would like to thank Rogue Resolutions Ltd for providing equipment and support for this study.